INFANCY
THE OFFICIAL JOURNAL OF THE INTERNATIONAL CONGRESS OF INFANT STUDIES

Infancy, **23**(5), 692–707, 2018

ISSN: 1525-0008 print / 1532-7078 online
DOI: 10.1111/infa.12246

WILEY Blackwell

Infants Discriminate the Affective Expressions of their Peers: The Roles of Age and Familiarization Time

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Research examining infants' discrimination of affect often uses unfamiliar faces and voices of adults. Recently, research has examined infant discrimination of affect in familiar faces and voices. In much of this research, infants were habituated to the affective expressions using a "standard" 50% habituation criterion. We extend this line of research by examining infants' discrimination of unfamiliar peers', that is, 4-month-olds, dynamic, facial, and vocal affective expressions and assessing how discrimination is affected by changing the habituation criterion. In two experiments, using an infant-controlled habituation design, we explored 3- and 5-month-olds' discrimination of their peers' dynamic audiovisual displays of positive and negative expressions of affect. Results of Experiment 1, using a 50% habituation criterion, revealed that 5-month-olds, but not 3-month-olds discriminated the affective expressions of their peers. In Experiment 2, we examined whether 3-month-olds' lack of discrimination in Experiment 1 was a result of insufficient habituation (i.e., familiarization). Specifically, 3-month-olds were habituated using a 70% habituation criterion, providing them with longer familiarization time. Results revealed that using the more stringent habituation criterion, 3-month-olds showed longer habituation times, that is increased familiarization, and discriminated their peers' affective expressions. Results are discussed in terms of infants' discrimination of affect, the role of familiarization time, and limitations of the 50% habituation criterion.

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Over the past 40 years, a substantial body of research has advanced our understanding of infants' discrimination and recognition of affect—including those factors that affect infants' discrimination and recognition of affect. These important skills provide a foundation for a variety of later achievements including the development of the self, the formation of social relationships, and early cognitive development (Leppänen & Nelson, 2009; Nelson, 1987; Rochat & Striano, 1999; Saarni, Campos, Camras, & Witherington, 2006; Stern, 1985; Walker-Andrews, 1997, 2008).

Infants' discrimination of affect

From near birth infants respond differently toward, and prefer, some vocal and facial expressions over others. For example, 3-day-old newborns prefer their mother's voice to an unfamiliar woman's voice and show a preference for a passage that was heard while in utero compared to an unfamiliar passage not heard in utero (DeCasper & Fifer, 1980; DeCasper & Spence, 1986). In addition, between 5 and 7 weeks of age, infants increase their looking to the eye region of a face when that face was moving and talking, compared to silently moving, or stationary (Haith, Bergman, & Moore, 1977). These and other early preferences are a foundation for infants' discrimination and recognition of different affective expressions.

Generally speaking, between 5 and 7 months of age infants discriminate and recognize a variety of affective expressions as conveyed by unfamiliar adults (see Walker-Andrews, 1997, 2008 for reviews). Moreover, infants' discrimination and recognition of affect are influenced by a variety of contextual factors (Flom & Bahrick, 2007; Walker-Andrews, 1997). Two of the most well-documented factors are whether the affective expressions are conveyed statically vs. dynamically or in a multimodal (auditory–visual) vs. a unimodal (auditory or visual) context.

Infants have shown discrimination and categorization of static emotional expressions under a variety of conditions. Using static black and white photographs, early research by La Barbera, Izard, Vietze, and Parisi (1976) found that 4- and 6-month-olds discriminated joy from anger and neutral or no affective expression, but did not discriminate a neutral and angry expression. Likewise, Young-Browne, Rosenfeld, and Horwitz (1977) demonstrated that 3-month-olds discriminated a surprised image and a happy facial image as well as a surprised facial image and a sad facial expression. Finally, by 9 months of age infants reliably discriminate static expressions of happiness and anger (Caron, Caron, & Myers, 1985).

Roughly between 5 and 9 months of age, infants discriminate *static* images conveying affect. These results, however, do not mirror infants' discrimination of affect using dynamic and multimodal (auditory–visual) expressions of affect. For example, Caron, Caron, and MacLean (1988) found that 4-month-olds discriminate dynamic happy and sad expressions. Furthermore, 4-month-olds only showed discrimination of happy–sad and happy–angry expressions when conveyed in a dynamic and multimodal context (i.e., presence of a voice–face). By 7 months of age, infants are able to use motion, that is dynamic point-light displays, in matching expressions of affect with a corresponding vocal expression (Soken & Pick, 1992). Furthermore, in a follow-up experiment, it was shown that 7-month-olds show intermodal matching of facial and vocal expressions of affect when the facial and vocal cues are presented 5 sec out of synchrony (Soken & Pick, 1999). More recently, and directly comparing infants' discrimination of multimodal and unimodal affective expressions, Flom and Bahrick (2007) found that even 4-month-olds discriminate happy, sad, and angry affective expressions in a dynamic and audiovisual (face and voice) context. However, it was not until 5 months of age that infants discriminated the expressions in a unimodal auditory context and 7 months of age that they discriminated them in a dynamic unimodal visual context (Flom & Bahrick, 2007). Taken together, the overall pattern of results indicates that infants' discrimination of affect first occurs in dynamic and multimodal contexts and then is extended to unimodal and static contexts.

Effects of familiarity

Another and equally important factor affecting when infants show discrimination and recognition of affect is infants' familiarity with the person conveying the affective expression. Infants, for example, show recognition of affective expressions at younger ages when a familiar face, that is the infant's mother, is presented. For example, 3.5-month-olds were found to recognize, and by implication, discriminate, happy or sad facial and vocal affective expressions of their mother, but not their father (Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002). Similarly, infants show affect recognition when the face is that of a peer (i.e., an unfamiliar infant of a similar age). While the faces of an infant's parents, including their expressions of affect, are more familiar to the infant than the faces and expressions of an unfamiliar adult, the affective expressions of an infant's peers are also familiar to the infant. In other words, because infants are frequently exposed to their own faces and are familiar with how their own affective expressions sound and feel, as well as the intensity of these expressions, it is possible that this "multisensory familiarity" promotes infants' discrimination and recognition of their peers' affective expressions. Furthermore, it has also been shown that 87% of 5-month-olds and 83% of 3-month-olds have daily exposure to their own face within a mirror (Bahrick, 1995; Bahrick, Moss, & Fadil, 1996) and are thus likely to be familiar with their own facial expressions and appearance.

Recently, and in an experiment, using the faces and vocalizations of infants, that is peers, 5-month-olds showed reliable intermodal matching, that is recognition, of both positive and negative affective expressions (Vaillant-Molina, Bahrick, & Flom, 2013). Thus, while infants between 5 and 7 months of age typically show recognition of some affect/affective expressions as conveyed by the faces and voices of unfamiliar adults in dynamic and multimodal contexts, slightly younger infants (3.5–5 months of age) recognize affective expressions when the individual or affective expression is of a peer and likely to be more familiar to the infant in terms of how they convey or communicate expressions of affect—or what we previously labeled as multisensory familiarity. Because infants show intermodal recognition of their peers' affective expression at slightly younger ages, one purpose of the current experiment was to examine, and at slightly younger ages, whether infants show discrimination of their peers' dynamic and multimodal affective expressions.

Amount of familiarization

If infants' *familiarity* with the face affects infants' discrimination of affect, it is also likely that the amount of *familiarization* time also influences infants' discrimination of other's affective expressions. Several studies have examined within the context of a fixed-trial visual paired comparison procedure how changes in the amount of familiarization time affect infants' perceptual learning and discrimination (e.g., Bahrick & Newell, 2008; Fair, Flom, Jones, & Martin, 2012; Hunter & Ames, 1988; Rose, 1980, 1983; Rose, Jankowski, & Feldman, 2002a). Only two studies, however, have explored how changes in the amount of familiarization within an infant-controlled habituation procedure affect infants' perceptual learning and discrimination (Flom, Gentile, & Pick, 2008; Schöner & Thelen, 2006). A second purpose therefore of this experiment is to examine how changes in the amount of familiarization time, that is changes in the criterion of habituation, affect infants' discrimination of their peer's affective expressions.

Using a fixed-trial visual paired comparison procedure, Rose (1980), for example, found that when 6-month-olds were provided 5–20 sec of familiarization, full-term but not age-corrected preterm infants showed visual recognition, that is, novelty preferences. Furthermore, preterm infants' visual recognition improved when the familiarization time was increased and both preterm and full-term infants processed information more quickly with increasing age. Yet, Rose (1983) further found that at 6 and 12 months of age, preterms continued to require more time to show a novelty preference, that is recognition of a 3D object, than full-terms. More recently, Rose et al. (2002a) provided longitudinal evidence that preterm infants take about 20% more trials and about 30% more time to reach the same level of familiarization as full-term infants. Thus, preterm infants process information more slowly than full-term infants even after correcting for chronological age.

Similarly, Bahrick and Newell (2008) found age-related differences in the depth of processing of dynamic faces and actions in typically developing 5.5- and 7-month-olds as a function of familiarization time. Specifically, when infants were provided 160 sec of familiarization both 5.5- and 7-month-olds discriminated a change in a female actor's dynamic action (i.e., blowing bubbles, brushing hair, putting on make-up), yet only the 7-month-olds noticed the change in the identity of the actors. If, however, familiarization was doubled to 320 sec, then infants at both ages discriminated the change in both the faces and actions. Likewise, when 12-month-olds were provided with 20 sec of familiarization, they failed to discriminate a novel from a just familiarized monkey face. However, if familiarization was increased to 40 sec, then 12-month-olds reliably discriminated the familiarized monkey face from a novel monkey face (Fair et al., 2012). Thus, as expected, increasing the time of familiarization affects whether infants discriminate objects, faces, or the actions and faces of unfamiliar adults.

In the foregoing experiments (e.g., Bahrick & Newell, 2008; Fair et al., 2012) and others (e.g., Hunter & Ames, 1988; Rose, 1980, 1983; Rose et al., 2002a), familiarization was manipulated by increasing the number and/or length of the familiarization trials. Furthermore, the results of these studies are methodologically important because they highlight the fact that infants' discrimination of actions/events, faces, and so forth is not only affected by their age, by prematurity of birth, but also, and not surprisingly, by the amount, or duration, of familiarization.

One of the most ubiquitous methods of examining infant perceptual and cognitive development, including the current experiment, is the use of the infant-controlled habituation procedure. With this procedure, infants are presented with the same event on successive trials until their looking time decreases by predetermined percentage (usually 50% decline from initial looking). Following habituation, infants are presented with a changed event and infants' looking to the changed event is compared to their final looking during habituation. Infants who show discrimination between the two events show an increase, that is visual recovery, in their looking from habituation to the test trials. In contrast, infants who fail to show discrimination do not show an increase, that is visual recovery, in their looking from habituation to the test trial.

Schöner and Thelen (2006, p. 275) summarized findings from a myriad of habituation studies and found, not surprisingly, that younger infants, compared to older infants, require more habituation trials (or perhaps a more stringent criterion of habituation) for novelty preferences to emerge. Put another way, younger infants habituate more slowly than older infants. A common feature of many, if not most experiments using the infant-controlled habituation procedure is defining the criterion of habituation as a 50% decrease in looking from infants' initial looking or baseline. This 50% habituation criterion has been dubbed the "industry standard" by Aslin (2007, p. 49). However, imposing the same (50%) habituation criterion on infants of different ages—the typical practice—may result in younger infants not being as habituated, or familiarized, as older infants when they reach the criterion of habituation.

As previously reviewed, increasing familiarization time within fixed-trial visual paired comparison procedures promotes infants' perceptual learning and discrimination. Thus, it is also likely that using a more stringent criterion of habituation, which would increase infants' time, or degree of familiarization, will similarly enhance infants' perceptual learning and discrimination. Aside from a study by Flom et al. (2008), little is known about how changing the criterion of habituation affects infants' perceptual discrimination. Flom et al. (2008) found using a 50% habituation criterion that 9-month-olds discriminated happy from sad musical excerpts as well as sad from happy musical excerpts. In contrast, 5- and 7-month-olds only discriminated these musical excerpts when habituated to sad music and tested with happy music (Flom et al., 2008). In a follow-up experiment, however, Flom and Pick (2012) found that 5- and 7-month-olds discriminated sad from happy music as well as happy from sad music when they accrued more familiarization time under a 70% habituation criterion. Thus, like providing increased familiarization time in fixed-trial visual paired comparison procedures, the use of a more stringent habituation criterion also results in increased familiarization time and can ultimately affect whether infants show discrimination.

Developmentally, infants of different ages (and of course experience) become familiarized to various features or properties of an event at different rates. By increasing the criterion of habituation, that is time of familiarization, therefore, one also increases the possibility that infants will have their attention directed toward and become familiarized to the property, or attribute, under investigation. As obvious as this seems, this is significant because it is possible in countless studies of infant cognition and perceptual development where infants failed to show discrimination after reaching habituation, those infants may in fact have been able to show discrimination if they were provided additional time of familiarization, for example a more stringent habituation criterion.

The purpose of the current investigation was to (1) examine 3- and 5-month-olds' discrimination of their peers' positive and negative dynamic and multimodal facial and vocal expressions; and (2) assess the role of familiarization time (manipulated using two different habituation criteria). In Experiment 1, we habituated 3- and 5-month-old infants to emotional expressions using the standard 50% habituation criterion.

Five-month-olds, but not 3-month-olds, discriminated the affective expressions. In a second experiment, we examined whether using a more stringent 70% habituation criterion, that is increasing the time of familiarization, would lead 3-month-olds to discriminate the affective expressions.

EXPERIMENT 1: 3- AND 5-MONTH-OLDS' DISCRIMINATION OF AFFECT

Method

Participants

Twenty 3-month-olds and twenty 5-month-olds participated (18 girls and 22 boys). The mean age of the 3-month-olds was 92 days ($SD = 4$), and the mean age of the 5-month-olds was 151 days ($SD = 8$). The data of 13 additional infants (eight 3-month-olds and five 5-month-olds) were excluded. Eight infants (six 3-month-olds and two 5-month-olds) were excluded due to fussiness. Two 3-month-olds and one 5-month-old were excluded for fatigue (see Procedure for details). Two 5-month-olds were excluded for equipment failure. All infants were healthy and full-term, that is ≥37 weeks, weighing at least 5 pounds at birth with 5-minute Apgar scores of 7 or higher. Participants were recruited from local birth records. Finally, both experiments were conducted according to guidelines laid down in the Declaration of Helsinki, with written informed consent obtained from a parent or guardian for each infant before any assessment or data collection. All procedures involving human subjects in this study were approved by the IRB at Brigham Young University.

Displays

There were four dynamic video displays consisting of one male and one female 4-month-old infant, each conveying a positive and a negative dynamic affective expression. Displays were chosen from among 10 4-month-olds (five females and five males) filmed from the shoulders up against a standard background while seated in an infant seat. Positive expressions were created by having the infant's mother silently interact with her child out of camera view (e.g., smiling, opening her mouth, widening her eyes) and encouraging her infant to smile and convey positive vocal expressions. Negative affective expressions were created by filming the infant, seated in the infant seat, while the experimenter and parent left the room and observed from a one-way mirror. Filming the infant, while left alone, continued until the infant became upset (i.e., fussing, whimpering, squinting of eyes, reddening of the face); however, crying was not included as part of the affective expression. Parents of the infants used in filming had participated in a prior experiment when their infant was 3 months of age and were specifically recruited for filming to provide potential experimental events. Each parent provided consent to have their child filmed for possible inclusion within the experiment, including the use of static images of their infant in professional presentations and publications.

The events were edited by taking 10–12 sec of the infant's positive and 10–12 sec of the infant's negative affective expression and looping each 6 times to create a 60-sec negative and a 60-sec positive event from each infant. Each of the ten infant actors was rated by 15 undergraduates. Undergraduates were instructed to identify which affect was being conveyed (happiness, sadness, fear, surprise, or don't see it) and to rate the "quality" of each affective expression using a 7-point Likert scale. All events were correctly identified as positive/happiness or negative/sadness, and the male and female infant actor with the highest overall ratings was chosen for the displays. The range for the females, across both affects, was 5.2–6.3 and for the males, it was 5.0–6.5. The male actor chosen had an overall mean rating of 6.5 (SD = 0.93), and the female had mean rating of 6.3 (SD = 1.1). Still images of the male and female infants portraying positive and negative affect chosen for the displays are shown in Figure 1. In addition to the primary events, a control event was also created and used. This event consisted of plastic wind-up fish that wiggled back and forth and created a clacking sound as the tail moved.

Apparatus

The displays were filmed using a Sony HD Camcorder and were edited with iMovie. All movies, that is, events, were presented using PowerPoint, a MacBook Pro laptop, and were presented to a 42" video monitor. The soundtracks were presented from a speaker placed on top of the monitor. The sound measured 65 dB (DSM 110 sound level meter) from the infant seat that was placed 60 cm from the monitor. A three-panel black foam board surrounded the video monitor used to present the events and prevented infants from seeing the observers.

One experimenter presented the events to the infant. In addition, two observers, unaware of the hypotheses of the experiment and unable to view the visual events, monitored infants' visual fixations by depressing a button while the infant fixated on the event and released it while the infant looked away. The two observers were also blind to the auditory information presented to the infant. Observers wore iPods that played music loudly enough to mask the vocalizations. The button box was connected to a computer programmed to record visual fixations online and to signal or cue to

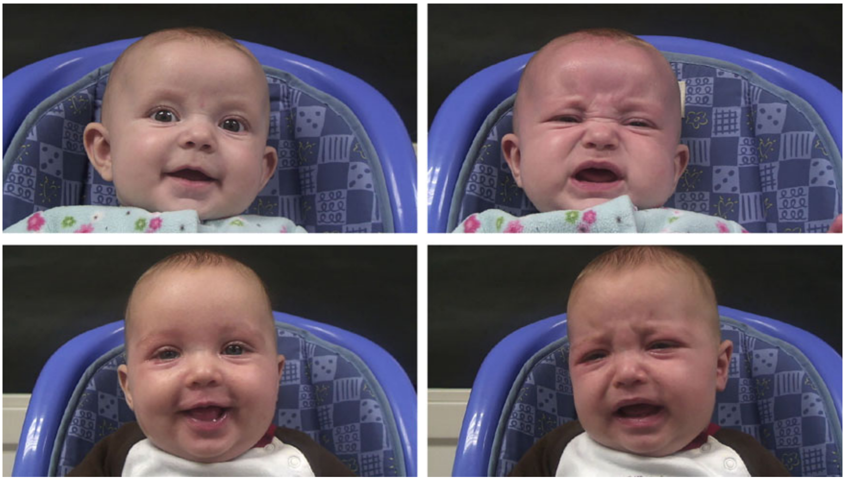

Figure 1 Screen captures of stimuli used in Experiment 1. Left-hand photographs show positive expressions, and right-hand photographs show negative expressions.

the experimenter who controlled the presentation of the video displays. The signal was transmitted to the experimenter through headphones. The observations of the primary observer controlled the presentation of the displays. Observations of the secondary observer were used in the calculation of interobserver reliability.

Procedure

Participants were habituated using an infant-controlled habituation procedure with the standard 50% habituation criterion (Horowitz, Paden, Bhana, & Self, 1972) to one of the two infant actors. Half of the infants at each age were habituated to the female actor and half to the male actor. We also counterbalanced the affective expression of habituation. Thus, 25% of the participants at each age were habituated to the positive expression of the female actor, 25% to the negative expression of female actor, 25% to the positive expression of male actor, and 25% to the negative expression of male actor. We did not pair participants with the same-sex actor.

The habituation sequence was similar to that of prior studies (see Bahrick & Lickliter, 2000; Flom & Bahrick, 2007; Flom & Pick, 2012). Specifically, each habituation sequence consisted of a minimum of six infant-controlled habituation trials. A trial began when the infant looked toward the video display and ended when the infant looked away for more than 1.5 sec. Sixty seconds was set as the maximum trial length, and 20 trials were the maximum number of trials. The standard habituation criterion was used and defined as a 50% decline in looking on two consecutive trials compared to infants' average looking time on the first two trials (i.e., baseline trials). After the habituation criterion was met, two no-change posthabituation trials were presented. Following the two no-change posthabituation trials, infants received two test trials where the affective expression was changed (negative to positive or vice versa). The actor did not change from habituation to test. Infants' discrimination of affect was assessed by their visual recovery, that is, infants' average looking during the two test trials minus their average looking during the two posthabituation trials. Prior to beginning of the habituation sequence, a control event (the wind-up fish) was presented and was also used after the presentation of the test trials to examine infants' overall level of fatigue. To identify infants who were fatigued, on the final control trial, infants were required to look at least 20% of their initial looking level. The data for two 3-month-olds and one 5-month-olds were excluded for failure to meet this criterion.

The two observers recorded each infant's visual fixations. The recordings of the primary observer controlled the presentation of the displays, and the recordings of the secondary observer were used in the computation of interobserver reliability. The second observer was present for 17 of the 40 infants (42.5%) included in the final analyses. Interobserver reliability was calculated by a Pearson product–moment correlation and averaged $r = .95$ ($SD = 0.03$). The interobserver reliability for the 3-month-olds ($n = 8$) was $r = .96$ ($SD = 0.03$) and for the 5-month-olds ($n = 9$) was $r = .94$ ($SD = 0.02$).

Results

Infants' looking time at each age for each trial type, baseline, posthabituation, and test, is presented in Table 1 along with infants' visual recovery and the number of trials and time to reach habitation. The primary dependent variable is infants' visual recovery (i.e., difference in looking during the test trials vs. posthabituation trials) to a change in affective expression and indexes discrimination. A repeated-measures analysis of variance (ANOVA) was performed with age (3- and 5-month-olds) as the between-subjects factor and trial type (baseline, posthabituation, and test) as the repeated measure. Results revealed a significant effect of trial type, $F_{(2,76)} = 113.9$, $p < .01$, effect size, $\eta^2 = .75$; a significant trial type by age interaction, $F_{(2,76)} = 4.2$, $p < .05$, effect size, $\eta^2 = .10$; and a nonsignificant effect of age, $F_{(1,38)} = 0.59$, $p > .1$, effect size, $\eta^2 = .02$. Scheffe's post hoc comparisons explored the main effect of trial type and revealed that across both ages, the overall looking during the posthabituation trials was less than the baseline trials, $F_{(2,76)} = 94.8$, $p < .01$, indicating infants' looking decreased from the initial or baseline trials, that is, they habituated. Importantly, the results of the age by trial type interaction, and subsequent post hoc comparisons, revealed that infants showed significant visual recovery at 5 months but not at 3 months of age. That is, 5-month-olds, but not 3-month-olds, looked longer during the test trials compared to the posthabituation trials, $t(38) = 9.7$, $p < .01$. In addition, the results of a paired-samples t test revealed that 3-month-olds' visual recovery reliably differed from that of the 5-month-olds, $t(38) = 2.5$, $p < .05$. Thus, infants at both ages showed evidence of habituation, yet only the 5-month-olds discriminated a change in the affective expressions of their peers. Furthermore, 5-month-olds also showed reliable discrimination when habituated with their peers' positive affect and tested using negative affect ($M = 6.8$, $SD = 6.6$), $t(9) = 3.2$, $p < .01$, and when habituated with their peers' negative affect and tested using positive affect ($M = 19.2$, $SD = 20.2$), $t(9) = 3.0$, $p < .05$. In contrast, 3-month-olds did not show reliable discrimination when habituated with their peers' positive or negative affect (both $ps > .1$).

Studies of individual differences within habituation designs often reveal that faster habituators show greater evidence of discrimination (i.e., visual recovery) than slower habituators (Colombo, 1993; Oakes, 2010). Because 3-month-olds failed to show

TABLE 1
Mean Visual Fixation (and Standard Deviations) in Seconds for Baseline, Posthabituation, Test Trials, and Visual Recovery as a Function of Age and Habituation Criterion

50% habituation criterion Experiment 1			*70% habituation criterion Experiment 2*
Age	*3-month-olds*	*5-month-olds*	*3-month-olds*
Trial type	*M (SD)*	*M (SD)*	*M (SD)*
Baseline	44.4 (17.2)	40.3 (16.8)	51.4 (13.2)
Posthabituation	5.8 (5.6)	5.7 (2.9)	5.3 (3.1)
Test	8.4 (7.7)	18.7 (16.9)	15.9 (15.3)
Time to habituation	210.5 (114.8)	198.6 (108.6)	321.5 (161.5)
Trials to habituation	7.3 (1.8)	7.9 (2.9)	10.2 (4.2)
Visual recovery (test-Posthabituation)	2.6 (8.9)	13.0 (15.9)**	10.5 (15.8)**

Notes. Baseline is the mean visual fixation during the first two habituation trials and reflects initial interest. Posthabituation is the mean visual fixation to two no-change trials just after the habituation criterion was met and reflects final interest in the habituated events. Test is the mean visual fixation during the two change or test trials. Visual recovery is the difference between visual fixation during the test trials and the posthabituation trials. Time to habituation is the time (in seconds) to reach the 50% or 70% habituation criterion.
**$p < .01$.

significant visual recovery, we examined 3-month-olds' discrimination separately for fast and slow habituators (i.e., those above and below the median of 178 sec to reach habituation). Results of this analysis revealed that the mean visual recovery for both the fast ($M = .26$, $SD = 6.9$) and slow habituators ($M = 4.95$, $SD = 10.5$) failed to reach significance (both $ps > .1$).

We also examined whether infants' looking behavior during the baseline, posthabituation, and test trials differed based on the infant–actor and the affect used during habituation. Results of these analyses failed to reach significance (all $ps > .1$). Finally, two independent-samples *t* tests were conducted to determine whether 3- and 5-month-olds differed in their total looking time (number of seconds to reach habituation), or the number of trials to reach habituation across age. Results of these analyses also failed to reach significance (all $ps > .1$).

Discussion

The results of Experiment 1 are clear. Five-month-olds, but not 3-month-olds, showed discrimination of positive and negative affective expressions as conveyed by their peers when using the standard 50% habituation criterion. One possible reason why 3-month-olds failed to show discrimination is that even though they habituated, they may not have been sufficiently familiarized with the expressions. In most studies using an infant-controlled habituation procedure, the criterion defining habituation is set at 50% (i.e., a 50% decrease from initial visual attention) for infants of all ages (Cohen, 2004). The logic behind this strategy is to maintain the same degree of habituation for all infants (Bornstein, 1985; Colombo & Mitchell, 1990). However, using the same habituation criterion across ages does not necessarily ensure that infants of different ages are habituated to the same degree (Schöner & Thelen, 2006; Thomas & Gilmore, 2004). Schöner and Thelen (2006) reviewed and simulated several fixed-trial habituation studies. One result of their simulation is that it is possible that younger infants (as well as slower habituators) may require more trials or looking time to reach habituation, thus affecting if the infant shows a novelty or familiarity preference. Using the same habituation criterion, for example 50%, "some infants will have had insufficient time to fully encode the target, whereas others will be forced to continue attending even when they have finished processing the target" (Rose, Jankowski, & Feldman, 2002b; p. 436). In other words, even though an infant reaches the habituation criterion, this criterion may not provide sufficient time for familiarization or processing of the to-be-learned object or event. From this perspective, it is unclear whether 3-month-olds failed to discriminate their peers' positive and negative affective expressions because they are unable, or whether 3-month-olds would show discrimination if they were more familiarized and had more time to encode the expressions (Schöner & Thelen, 2006).

Given that infants, depending on their age, may require more or less time to become familiarized to different events, researchers have explored the effects of different durations of familiarization on infants' perceptual and cognitive processing (e.g., Bahrick & Newell, 2008; Fair et al., 2012; Rose, 1980, 1983). However, aside from Flom et al. (2008), little is known about how the choice of a habituation criterion affects infants' perceptual and cognitive processing. The purpose of Experiment 2 therefore was to examine whether 3-month-olds would show reliable discrimination of their peers' affective expressions with a 70% habituation criterion, thus increasing the time of familiarization.

EXPERIMENT 2: 3-MONTH-OLDS' DISCRIMINATION OF AFFECT USING A 70% HABITUATION CRITERION

Method

Twenty 3-month-olds participated (10 girls and 10 boys), and their mean age was 92 days (*SD* = 3.5). The data of nine additional infants were excluded from the final analyses. Three infants were excluded due to excessive fussiness.[1] Three infants were excluded for equipment failure and three for failure to habituate in fewer than twenty trials. All infants were healthy, normal, full-term infants weighing at least 5 pounds at birth, with 5-minute Apgar scores of 7 or higher.

The displays and apparatus were those of Experiment 1. All procedures and counterbalancing were identical to Experiment 1 with the exception that the habituation criterion was defined as a 70% decline in looking on two consecutive trials compared to infants' average looking time on the first two trials (i.e., baseline trials).

As in Experiment 1, infants' fatigue was assessed by comparing each infant's looking on the first and the final control trials (i.e., the moving fish), and infants were required to look at least 20% of their looking on the first control trial. No infants were excluded for failure to meet this criterion.

Results

As in Experiment 1, the dependent variable was infants' visual recovery to a change in affect conveyed by their peers (see Table 1). In Experiment 2, a repeated-measures design again examined 3-month-olds' looking behavior by trial type. The results of this analysis reached significance, $F_{(2,38)} = 78.5$, $p < .01$, effect size, partial $\eta^2 = .81$. Scheffe's post hoc comparisons explored the effect of trial type and revealed that the overall looking during the posthabituation trials (*M* = 5.3, *SD* = 3.1) was less than the baseline trials (*M* = 51.4, *SD* = 13.2), $p < .01$, indicating infants did habituate. In addition, 3-month-olds' looking during the test trials (*M* = 15.9, *SD* = 15.3) exceeded their looking during the posthabituation trials, $p < .01$. Thus, when a more stringent habituation criterion was imposed, 3-month-olds showed reliable discrimination of their peers' positive and negative affective expression.[2] The results of Experiment 2 further indicate that when habituated to their peers' positive affect, 3-month-olds showed reliable discrimination (*M* = 9.2, *SD* = 12.5), $t(9) = 2.4$, $p < .05$, but not when habituated to their peers' negative affect (*M* = 11.7, *SD* = 19.1), $t(9) = 1.9$, $p = .08$. The results of Experiment 2 also indicate that 3-month-olds' looking behavior was not affected by the actor, or peer used, during habituation, $p > .1$.

[1]In Experiment 1, four 3-month-olds were excluded for fussiness. Thus, the 70% habituation criterion in Experiment 2 did not increase the number of infants excluded for fussiness.

[2]We also pilot-tested twelve 2-month-olds (*n* = 6) at the 70% criterion. Five of the six infants at the 70% criterion became fussy. All 2-month-olds (*n* = 6) habituated using the 50% criterion reached habituation but failed to show discrimination.

A second repeated-measures analysis of variance was also performed to compare the 3-month-olds in Experiment 1 (50% habituation criterion) with the 3-month-olds of Experiment 2 (70% habituation criterion). Trial type (baseline, posthabituation, and test) was used as the repeated measure with habituation criterion (50% and 70%) as the between-subjects factor. Results revealed a significant effect of trial type, $F_{(2,37)} = 188.6$, $p < .01$, effect size, $\eta^2 = .91$; a significant trial type by habituation criterion interaction, $F_{(2,37)} = 3.8$, $p < .05$, effect size, eta-squared = .17; and a significant effect of habituation condition, $F_{(1,38)} = 4.96$, $p < .05$, effect size, $\eta^2 = .11$. Not surprisingly the main effect of trial type revealed that, across both habituation criteria, looking during the baseline trials was greater than that of the posthabituation trials, $p < .01$, demonstrating habituation. Importantly, however, the results of the habituation criterion by trial type interaction revealed that 3-month-olds' looking on the test trials ($M = 8.4$, $SD = 7.7$; $M = 15.9$, $SD = 15.3$) differed for the 50% and 70% habituation criteria respectively. Thus, 3-month-olds in the 70% habituation condition looked longer than 3-month-olds in the 50% habituation condition during the test trials but not during the baseline or posthabituation trials. Similarly, 3-month-olds' visual recovery in the 70% habituation condition ($M = 10.5$, $SD = 15.8$) significantly differed from 3-month-olds' visual recovery in the 50% habituation condition ($M = 2.6$, $SD = 8.9$), $t(38) = 2.3$, $p < .05$.

Two independent-samples t tests were conducted to determine whether 3-month-olds in the 50% and the 70% habituation criterion condition differed in their looking time required to reach habituation. As expected, those infants in the 70% condition required more trials to reach habituation, $t(38) = 2.9$, $p < .01$, and took longer to reach the habituation criterion, $t(38) = 2.5$, $p < .05$. This difference in familiarization time likely provides the basis for visual discrimination of the change in affect.

GENERAL DISCUSSION

Previous empirical and theoretical research has documented how modifications to the amount of familiarization time affect infants' perceptual learning and discrimination using the visual paired comparison procedure and the fixed-trial habituation designs (e.g., Bahrick & Newell, 2008; Fair et al., 2012; Hunter & Ames, 1988; Rose, 1980, 1983; Schöner & Thelen, 2006). The current study extends this research to the infant-controlled habituation designs. Infant-controlled methods are typically more sensitive for revealing learning and discrimination than the visual paired comparison procedure because individual infants tailor their familiarization time to their own speed of processing allowing the majority of infants at a given age to become sufficiently familiarized to show a visual preference for novelty (Colombo, 1993; Colombo & Mitchell, 2009; Thomas & Gilmore, 2004).

Our results demonstrate that changing the criterion of habituation from 50% to 70% increases younger infants' familiarization time and subsequent discrimination of their peers' positive and negative affective expressions. Five-month-olds, but not 3-month-olds, discriminated their peers' positive and negative affective expressions when provided a 50% habituation criterion. Three-month-olds, however, were able to discriminate their peers' affective expressions only when provided a 70% habituation criterion, that is when provided additional familiarization time. Further, 3-month-olds showed discrimination when habituated to a positive affective expression and tested with a negative expression, but not when habituated to a negative affective expression. Together, the results demonstrate that both 3- and 5-month-olds discriminate their peers' positive and negative affective expressions when presented in a dynamic audiovisual context; however, 3-month-olds required additional familiarization time to reveal their perceptual discrimination.

By comparing 3-month-olds' looking behavior in the 70% and 50% criterion conditions, no difference was observed in their initial or baseline looking, posthabituation looking, or level of fatigue (i.e., difference in looking during the first and last control trials). However, in the 70% condition 3-month-olds took, on average, an additional 111 sec (i.e., 53% longer) to reach habituation and their visual recovery was significantly greater than in the 50% condition. Finally, the 70% habituation did not increase the number of 3-month-olds excluded for becoming fussy or fatigued. Thus, a more stringent habituation criterion led to an increase in familiarization time, and like prior visual paired comparison studies (e.g., Bahrick & Newell, 2008; Fair et al., 2012; Rose, 1980, 1983), it resulted in increased perceptual learning and discrimination.

One possibility is that younger infants processed the event of habituation differently than 5-month-olds. That is, younger infants are attending to different features of the event compared to older infants. Previous research examining the development of infant attention has shown behaviorally and neurophysiologically that when infants are first learning about a new property or event their attention is initially directed toward the redundant and multimodal properties of the event, and over time and experience their attention becomes more flexible such that they can attend to either multimodal properties or modality specific properties (Bahrick, Lickliter, & Flom, 2004). Therefore, it is likely that in Experiment 1, 3-month-olds' lack of discrimination was due to the fact that they were not sufficiently familiarized to the event to encode the redundant audiovisual information for affect; thus, 3-month-olds discrimination in Experiment 2 is likely due to the increase in familiarization time.

The current results extend our understanding of the dynamics of habituation and their effects on perceptual processing at different ages in infancy. Our results demonstrate that the traditional 50% habituation criterion may, in some cases, provide older, but not younger, infants with sufficient familiarization time to support discrimination. For example, Schöner and Thelen (2006) have argued that infant age interacts with task difficulty and the amount of familiarization required within fixed-trial habituation designs to show learning and discrimination. Thus, younger infants may require more trials or, in the case of infant-controlled trials, a more stringent habituation criterion (increasing familiarization time) to reach the same level of perceptual processing as older infants.

Previous studies have manipulated and found differences in infants' discrimination of faces as well as everyday actions based on differences in familiarization time using the visual paired comparisons procedure (Bahrick & Newell, 2008; Fair et al., 2012; Hunter & Ames, 1988). However, less is known about how changing the infant-controlled habituation criterion affects the dynamics of habituation and infants' perceptual discrimination (cf. Flom & Pick, 2012).

The current study extends this literature by demonstrating that a more stringent criterion of habituation increases familiarization time, which in turn enhances perceptual differentiation, and learning and discrimination. Using the same habituation criterion for infants of different ages, some infants will be fully habituated, whereas others will not be, and still others may become fatigued or overly habituated (Colombo &

Mitchell, 2009; Oakes, 2010; Richards & Casey, 1992; Schöner & Thelen, 2006). According to some perceptual differentiation progresses in order of increasing specificity (e.g., Bahrick & Lickliter, 2000, 2014; Bahrick et al., 2004; Gibson, 1969; Gibson & Pick, 2000), some properties of stimulation are differentiated earlier than others. Therefore, altering the habituation criterion based in part on age of the infant, as well as considering the nature of the event or display, will likely increase the probability that more, or most, infants will be fully habituated (Thomas & Gilmore, 2004). In contrast, if infants are not fully habituated, or have not fully encoded the to-be-learned event, the interpretation of their looking during the test trials would be ambiguous.

The current results also add to our understanding of infants' discrimination of affect (e.g., Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002; Vaillant-Molina et al., 2013). Specifically, our results reveal evidence of discriminating affective expressions of peers by infants as young as 3 months of age. Prior research has revealed affective discrimination by infants as young as 3.5 months of age, but only for highly familiar adults (their mothers—but not their fathers; Kahana-Kalman & Walker-Andrews, 2001; Montague & Walker-Andrews, 2002). Moreover, our results are likely due to the fact that the expressions were dynamic, multimodal, and posed by peers and that 3-month-olds were given sufficient familiarization time using the 70% habituation criterion.

The present study reveals new information about how modifications of the habituation criterion affect infant familiarization time and in turn perceptual learning and differentiation. The standard 50% habituation criterion was sufficient for 5-month-olds to show perceptual discrimination. However, 3-month-olds required a 70% habituation criterion which provided substantially more familiarization time (53% more) to support perceptual differentiation and discrimination in the same task. From a more applied and methodological perspective, our findings also raise the possibility that previous studies in which infants failed to show discrimination after reaching habituation may in fact be able to show discrimination if they were provided additional time of familiarization, for example a more stringent habituation criterion. Finally, future research assessing infant perceptual learning and discrimination should consider using a more stringent criterion of habituation if discrimination is not evident using the standard 50% criterion.

ACKNOWLEDGMENTS

This research was supported by a National Institutes of Child Health and Human Development (RO1 HD053776-06) awarded to the second author. The authors report no conflicts of interest.

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